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THE AMERICAN GAS LIGHT JOURNAL

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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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WE regret to record the death (at his home in Toledo, Ohio, on the morning of January 31st) of Mr. Horace S. Walbridge, who for more than a quarter of a century was prominently identified with the Toledo Gas Light and Coke Company.

[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

SECRETARY'S OFFICE, LYNN, MASS., Feb. 1, 1893.

The Twenty-third Annual Meeting of the New England Association of Gas Engineers will be held at Young's Hotel, Boston, on Wednesday and Thursday, February 15th and 16th, and will be called to order at 10 o'clock, Wednesday morning, the 15th.

The following papers will be read:

"Everyday Pyrometry," by Mr. Edward C. Jones, San Francisco Gas Light Company.

"Experiments on Removing Sulphur from Purified Gas," by Mr. George F. Goodno, Dedham and Hyde Park Gas Company.

"Reports," by Mr. Robert W. Bush, Boston Gas Light Company.

"Pressure Records on Mains and Services," by Mr. Samuel J. Fowler, Springfield Gas Light Company.

"Effects of the Trolley System on Gas and Water Pipes," by H. A. Allyn, Cambridge Gas Light Company.

It is expected that other papers will be presented whose titles will be announced later.

Applications for membership should be sent the Secretary in time to be acted upon by the Directors at their meeting, Tuesday evening, February 14th. Blank applications may be obtained of the Secretary.

C. F. PRICHARD, Secretary.

[OFFICIAL NOTICE.]

Committee of Arrangements, Chicago Meeting, American Association.

OFFICE OF THE SECRETARY, PROVIDENCE, R. I., January 31, 1893.

By the direction of the President I hereby announce the following appointments constituting the Committee of Arrangements for the Twenty-first Annual Meeting of the American Gas Light Association, to be held in the city of Chicago, Ills., beginning October 18th, 1893.

Carl D. Bradley (Chairman), Bouton Foundry Co., Chicago, Ills.

A. W. Littleton, Secretary Gas Company, Quincy, Ills.

E. G. Cowdery, Engineer Gas Company, Milwaukee, Wis.

Alten S. Miller, Manager National Gas Light and Fuel Company, Chicago, Ills.

H. M. Hubbard, Secretary Geo. M. Clarke & Co., Chicago, Ills.

C. D. Hauk, President National Gas and Water Company, Chicago, Ills.

Fred. R. Persons, Naphtha Department, Standard Oil Company, New York, N. Y.

Respectfully, A. B. SLATER, JR., Secretary.

BRIEFLY TOLD.

THE BOSTON MEETING.—With this issue, Secretary Prichard, of the New England Association, gives us a fairly good glimpse of what the members may look forward to on the technical account of the Twenty-third Annual Meeting, and we can congratulate the Secretary and the membership on the promise of the paper list. So far five numbers are assured, and as four of the writers have hitherto made their appearance in the role of paper contributors, which appearances were made with pronounced success, we have no doubt that their themes will be put forth in such a way as to interest their auditors and bring out discussion. The remaining author, Mr. Robert W. Bush, of Boston, has elected to treat a subject well out of the beaten track, and although this will be his initial appearance as a paper writer before the Association, his ability to compile reports is well known outside of the desk rooms of the Boston Gas Light Company. We also sincerely hope that Mr. Jones will be on hand in person to read his paper on "Everyday Pyrometry," but we fear that the plant betterments, at present all but completed at the San Francisco works, may detain him. President Wood, too, can be counted on to have something of moment to say in his review of the year's doings; and as Secretary Prichard holds out more than a hope that other papers are to be presented, it certainly goes that the technical side of the gathering will be all that could be desired. Those who pro-

pose to take membership in the Association ought to heed the admonition that applications should be forwarded to the Secretary, in time for the meeting of the Directors, to be held on the evening of the 14th. We also wish to say that we are empowered by the Secretary to extend an invitation to all friends of the Association to be present at the meeting, and that this line or two be accepted as such invitation; for this year no separate invitations will be mailed. The Association will welcome everyone who wishes success to the principles for which it so ably stands.

A Boomerang.—That versatile financier, Mr. J. Edward Addicks, whose wonderful accumulation of securities on the gas plants owned or controlled by him in Boston really needs to be indexed or catalogued, provided one has reason for keeping them in mind with any sort of ease, seems to have encountered, or appears to be in fair way of encountering, a wound. Not satisfied with "consolidating" the gas interests of Boston, or with having a sort of sinking fund gas investment over in Wilmington, Del., he hungered after the Brooklyn gas field, but in the preliminary laying hold thereof he met with some people who were not as complaisant, for instance, as was the Board of Directors of the old Boston Gas Company. These Brooklyn men thought they could take care of the gas field of their own city, and when Mr. Addicks had reached the point where his presence in Brooklyn was more an actuality than a mere menace, the Brooklynites took a journey up to the Boston gas field. There they found one or two serious flaws in the Addicks' armor, one of which consisted in the plant and franchises of the Brookline Gas Light Company, the proprietors whereof were inclined to part with their property if a good, round price were offered for it. The Brooklyn men offered that price, and it is quite likely that Dr. Amory and his asso ciates will accept the same. The effect of this countermove is evident. If Messrs. Jourdau, Rogers and Weidenfeld of Brooklyn secure the Brookline Company, the franchise of which permits it to supply gas in every part of the city of Boston, and if they put the price of gas on a war footing—an expenditure of $350,000 would put the Brookline Company in fair position to badger the Bay State magnate—the bonds and "warious" other Boston gas securities of Mr. Addicks might not be worth as much for purposes of hypothecation as they now are. However, it looks to be only a fair exchange—Mr. Addicks comes to Brooklyn, N. Y., and the Brooklyn men go to Brookline, Mass., and in each place they exchange the compliments of the season. All Napoleonic types of heroes usually come to the same end.

Mr. Egner Disclaims any Reflection on the Jones Jet Photometer.—The following letter from Mr. Frederic Egner, written from St. Louis, Mo., on January 31st, explains itself: To the Editor American Gas Light Journal: Mentioning in a recent article the fact that unprincipled promoters could use and have used that excellent little instrument known as the Jones Jet Photometer to deceive unprofessional people as to the value of gas as an illuminant, it was not within the writer's intention or thought to cast reflections either upon the inventor, the instrument, or any gas man who used it, and it is sincerely hoped that no one has thus interpreted my statement—although Mr. Jones seems to have done so. The writer has used the instrument mentioned, with entire satisfaction under certain conditions, and hopes to do so in the future. Its extreme cheapness, and because so many reputable gas men use it, are the reasons that tempt unscrupulous persons to employ same, after tampering with it, to deceive their victims. Trusting you will do me the favor to publish this letter, I am, with respect, yours truly, Frederic Egner.

Mr. Miller on Mr. Egner's Article on the Harris Gas Process.—Referring to Mr. F. Egner's article on "The Harris Process for Generating Gas," which appeared in the Journal for January 30th, Mr. Alten S. Miller, Manager of the National Gas Light and Fuel Company, writing from Chicago, under date of January 31st, says:

To the Editor American Gas Light Journal: I read with considerable surprise the article on "Harris Gas Process," which was written by Mr. Egner. Without commenting on Mr. Egner's new idea of nitrogen as an aid to combustion, it is very easy to show the fallacy of the claims made for the Harris process. Mr. Egner says that according to the statements of the operators, which he evidently believes to be true, that 8 lbs. of coal and 13¼ lbs. of heavy petroleum made 1,000 feet of gas. Let us suppose that the coal used was pure carbon, and that the efficiency of the machine was 100 per cent. The coal used would have $8 \times 14{,}500 = 116{,}000$ heat units; the oil used would contain $13\frac{1}{4} \times 20{,}000 = 270{,}000$ heat units. The sum of these is 386,000, or 46,640 heat units less than Mr. Egner's analysis shows in the finished gas. Further comment is unnecessary.

[Continued from page 153.]

Generation of Light from Coal Gas.

[The last of a series of four Cantor Lectures, delivered by Vivian B. Lewes, F.I.C., F.C.S., before the English Society of Arts.]

With the last lecture I brought to a conclusion our theories as to the cause of luminosity in coal gas flames, and to-night I desire to discuss the question of the methods which we employ for the combustion of the gas, and how far these are in accordance with the theory.

As may easily be imagined, the first burner used for the consumption of coal gas was the end of the tube from which it was issuing, but Murdoch, the father of gas lighting, soon saw that the consumption was far too high, and the illuminating value far too low to make this a successful method of burning his new illuminant, and casting about to find a method of retarding the flow, he fitted an old thimble over the end of the pipe, and this happening to have several pin-holes in the crown, he lighted the gas escaping from them to prevent it escaping into the room, and at once found that several small jets gave a far better light than the one big flame, besides causing considerable economy in the consumption of gas. But as his experiments progressed, the form of his burner was modified, until in 1807, when fitting up the works of Messrs. Philips & Lee, in Manchester, he used two forms of burners—the one a rough argand, and the other "a small curved tube with a conical end, having three circular apertures or perforations, about a thirtieth of an inch in diameter, one at the point of the cone, and two lateral ones, through which the gas issuing formed three divergent jets of flame, somewhat like a *fleur-de lys*." The latter burner, which, from the shape of the jet, received the name of the "cockspur" burner, gave a light equal to 2¼ mould candles of six to the pound, while the argands used developed a light equal to four candles of the same description. The argand burner had been in use for the consumption of oils for some years before the introduction of coal gas, and in its early form consisted simply of two concentric tubes fixed at the required distance apart, the coal gas being fed in between them. Soon, however, the idea arose of closing the open circular slot by a metal ring pierced with holes, so as to give a circle of small jets; and even prior to 1816, the main principles of our present argands were found to be in the burners in use. It was about 1816 also that the cockspur burner became converted into the cockscomb and then the batswing—thus marking a distinct advance in the method of burning the gas, as by spreading the flame out into a thin sheet instead of having it in a solid mass as in the jet burner, the air was more uniformly and readily supplied to the burning gas, and the increased temperature of the flame, due to the more perfect combustion, increased the light-giving power of the burner to nearly that of the argands then in use.

In 1820, Neilson, of Glasgow, whose name will always be remembered as the discoverer of the hot blast in iron smelting, found that, by allowing two flames to impinge upon each other, an increase in luminosity was obtained; and, after several preliminary stages, the union jet, or fishtail jet, was produced, in which two holes, bored at the necessary angle in the same nipple, caused two jets of gas to impinge upon one another, so that they mutually splayed themselves out into a flat flame. The shape of the batswing flame was a very wide flame, of but little height, while the fishtail was much higher and narrower; and, although the service yielded by the fishtail for each foot of gas consumed was no better than, if it were as good as, that given by the batswing, yet its shape, which made it less affected by draughts, and enabled a globe to be used with it, ensured a greater mead of success for it than the batswing burner had secured.

The next 20 years was a period of gradual improvement and perfecting of the argand and flat flame burners—the influence of pressure and regulation of the flow of gas to the burner being gradually realized and arranged for—whilst other structural improvements were introduced.

On the 20th of May, 1853, Dr. Frankland, whilst giving one of the Friday lectures at the Royal Institution, showed, but did not fully describe, an argand burner, in which the idea was first adopted of utilizing heat, which otherwise would have been lost, to raise the temperature of the air supply; and this burner was afterwards described in Ure's Dictionary, the article, however, only being published a year or more after it had been written.

In speaking of this, Dr. Frankland says:

"One of the conditions necessary for the production of the maximum illuminating power from a gas flame is the attainment of the highest possible temperature; but this condition has been almost entirely neglected in the burners hitherto in use. I have, however, experimentally proved that it may be easily secured by employing the waste heat radiat-

ing from a gas flame for heating the air in which the gas burns, and that the increased temperature thus obtained has the effect of greatly increasing the illuminating power of a given volume of the gas."

The burner consisted of an ordinary argand, but, in addition to the usual chimney, it had a second external one, which extended some distance below the first, and was closed at the bottom by a glass plate, fitted air-tight to the pillar carrying the burner, so that the air needed to support the combustion of the gas had to pass down the annular space between the two chimneys, and in its passage became highly heated, partly by contact with the hot inner glass, and partly by radiation.

The temperature of the air finally entering the burner Dr. Frankland considered to be about 500° F., and he says:

"The passage of this heated air over the upper portion of the argand burner also raises the temperature of the gas considerably before it issues from the burner. Thus the gases taking part in the combustion are highly heated before inflammation, and the temperature of the flame is consequently elevated in a corresponding degree. Experiments with this burner prove a great increase in light, due chiefly to the higher temperature of the flame, but also partly due to the decomposition of marsh gas, which renders the latter a contributor to the total illuminating effect, whilst it merely performs the functions of a diluent when burnt in the ordinary manner. The following are the results of my experiments with this burner:

	Rate of Consumption per Hour.	Light in Sperm Candles, each Burning 120 Grains per Hour.
1. Argand burner without external cylinder..	3.3 cubic feet....	13.0 candles.
	3.7 "	15.5 "
	4.2 "	17.0 "
2. Same burner with external cylinder.....	2.2 "	13 0 "
	2.6 "	15.5 "
	2.7 "	16.7 "
	3.0 "	19.7 "
	3.3 "	21.7 "

These results show that the new burner, when compared with the ordinary argand, saves on an average 49 per cent. of gas, when yielding an equal amount of light, and also that it produces a gain of 67 per cent. in light with an equal consumption of gas."

In 1854 the Rev. W. R. Bowditch brought out a burner identical in nearly every respect with the above; and as this was brought prominently forward, it attracted considerable attention, with the result that the inception of the regenerative burner has been generally ascribed to Bowditch, whilst that honor is undoubtedly due to Frankland.

In speaking of the Bowditch lamp, "Owen Merriman," in an excellent series of articles on gas burners, old and new, published in the *Journal of Gas Lighting*, says:

"This burner contained many defects. Amongst others, the inner chimney could not long withstand the intense heat to which it was subjected, and, in consequence, had to be frequently renewed, the heating of the air was not effected solely by the products of combustion, but perhaps in a greater degree by the abstraction of heat from the flame itself, while at best this heating was but partial. Yet, these defects notwithstanding, the burner showed very clearly the beneficial results attending even a partial application of the principle, as, in the illuminating power it developed from the gas consumed, a clear gain of 67 per cent. over the argand burner was obtained. Although the drawbacks connected with the construction of Mr. Bowditch's burner prevented its ever receiving general, or even extensive adoption, its simplicity has gained for it the distinction of being freely copied by so called inventors of a later day."

Dr. Frankland used his lamp in his study for 15 years, until, he says, "it was superseded by a paraffine oil lamp."

In 1879, Frederick Siemens, of Dresden, brought out his big burner, which, although one of the most effective, was also one of the most unsightly from its big overhead feed pipe. This burner was really first made for heating purposes, but the light it gave was so far ahead of any effect which had been obtained up to that time, that, with certain modifications, it was adopted for lighting purposes.

In 1881 Mr. Thwaite published in the *English Mechanic* a description of an overhead recuperative burner, under the name of the "hygienic lamp," and from that time up to the present, regenerative burners—good, bad and indifferent—have increased and multiplied with great rapidity, the chief differences between them being in their names and slight details of design.

About the same time that the regenerative burner was struggling into prominence, Mr. Lewis brought out a burner in which the coal gas was consumed mixed with air, as in a bunsen burner, and the flame was then urged by an artificial blast against a cone of fine platinum wire, which, being heated to incandescence, gave a very high candle power per cubic foot of gas consumed, and was thus the forerunner of the Welsbach, Clamond and other incandescent lights.

Having traced the gradual genesis of our present burners, we must now see how the burners comply with the theories I have laid before you.

There are two special points to be observed in order to produce a luminous flame. Firstly, to use a hydrocarbon that is easily converted into acetylene by means of heat; and secondly, to have as hot a flame as possible. These two conditions now pointed out by theory, have long been known in practice, gas managers realizing that the larger the quantity of olefines, etc., in their gas, the better its candle power, and burner makers have discovered that the regenerative burner gives by far the best results per cubic foot of gas consumed.

But why, then, it may be asked, does high temperature retorting give such a poor gas, containing only a trace of acetylene? The reason is that acetylene heated to a high temperature insufficient to decompose it, polymerizes into bodies such as benzine, naphthaline, etc., which go to make the tar better at the expense of the gas. In fact, by passing coal gas through a heated platinum tube, I have been able to obtain naphthaline in considerable quantity, and at the same time the gas has deteriorated, so you see that superheating the gas itself during manufacture can only end in failure.

But supposing it were possible to charge our gas with acetylene, it is so soluble in water or glycerine that it would all be absorbed in the gasholder and meters, and very little would come into the flame.

So we find that we must depend upon the gas flame itself for the production of acetylene; the luminosity of the flame results from having the acetylene formed in just the right place to be split up by the greater heat it encounters in passing up the flame. A mixture of hydrogen and 3 per cent. acetylene burns with very little greater luminosity than a mixture of 3 per cent. ethylene and hydrogen, simply because by the time the temperature of the flame is high enough to decompose it a large amount has been burnt up.

We have two methods of raising the illuminating power of the gas, either by increasing the amount of acetylene-forming gases—which is expensive—or by regeneration. Regeneration acts in two ways—firstly, by increasing the initial temperature of the flame, as then we have the blue zone decreased in size because the temperature necessary to split up the acetylene is reached sooner, and therefore less is burnt without decomposition; also the higher the temperature the more marsh gas is converted into acetylene. Secondly, the inert nitrogen of the atmosphere being at a high temperature to start with, abstracts less heat from the flame, and therefore the carbon particles are heated to a higher state of incandescence.

Through the kindness of Mr. Siemens, I have been enabled to measure the effect of regeneration on a flat flame.

The flame, when cold, had an area of 11 square inches, the luminous portions of which occupied 7.8 square inches, and the non-luminous 3.2 square inches. On regenerating this flame, the area decreased to 10.2 square inches, but the luminous zone occupied 7.9 square inches, whilst the non-luminous zone only occupied 2.5 square inches, the illuminating effect being more than doubled.

But regenerative gas burners, on account of their initial cost, are but little used—at any rate, for domestic purposes—and the flat flame burner is still the popular one. By the use of even the improved forms of flat flame burners a great deal of the possible illuminating effect of the gas is lost, and the problem is, how may those burners be improved? And you will pardon my spending a few moments in pointing out the direction in which it seems possible to accomplish this.

When the gas issues from the jet, the hydrogen and marsh gas, having the least density, diffuse outward and burn, the olefiant gas not diffusing so rapidly; but the larger the non-luminous zone, the greater the loss of unsaturated hydrocarbons; so that if we can by any means decrease the size of the blue zone, we not only gain a larger luminous zone, but also more particles of carbon.

About 35 years ago, a method of increasing the luminosity of a flat flame, called "Scholl's platinum light perfector," was introduced. It consisted of a thin strip of platinum, fixed across the burner between the orifices of the jet, so that the two streams of gas impinged upon it. The explanation given of its action was that it broke the rush of gas, and so brought about more perfect combustion. While the burner was new, it did undoubtedly improve the illuminating effect, but, after a certain time, it fell off considerably, which would not have been the case had the effect been purely mechanical. Platinum has the property—together with one or two other rare metals—of condensing gases on its surface, and making them, to a certain extent, more active chemically. For instance, if a piece of platinum wire be held in a gas flame,

then the gas turned off, the platinum allowed to cool, and the gas turned on again, the wire will become red-hot, owing to the combination of the oxygen and hydrogen that have been condensed on its surface, and the temperature will often rise high enough to re-ignite the flame.

This action no doubt took place in the perfector, thereby adding to the heat in the non-luminous portion of the flame and thus reducing its size, and that the increase in luminosity was due to this cause is shown by the fact of its deterioration after it had been used a short time, as the carbide of platinum formed by the hydrocarbons attacking the platinum has not the property of condensing gases, and it is this formation of carbide of platinum which has prevented platinum incandescent lamps from becoming a success.

By placing a platinum wire in the non-luminous portion of the flame, taking care not to distort it, we can make that portion of the flame smaller in size, the platinum acting in the same manner as in the perfector. The non-luminous portion of the flame may be reduced in another way, that is by increasing the rate of combustion at the base of the flame and thereby increasing the temperature. This was done by Sir James Douglass with his multiple argand, in which a number of flames burnt one within the other, and by means of deflectors a current of air was made to impinge upon the outer flames at their base; by this means, though very little light was obtained from the outer flame, the inner ones were intensely heated and the candle power of the gas per cubic foot doubled. Another example is to be found in Sugg's "London" argand, and a gas which gave over 16 candle power when burnt in this argand gave only 14-candle power when burnt in some old standard argand burners which I tested, and in which the air supply was less perfectly arranged.

The most successful attempt probably yet made to increase the illuminating power of flat flames was in arranging two separate burner at such an angle to each other that the flames impinged and gave a luminosity considerably in excess of that given by the two flames when burning apart. This is caused by the fact that part of the heat radiated from one flame is utilized in heating the other, and also by an up-current being formed at the base of the flame you get the temperature rising more rapidly. The best of these burners are made with the two nipples fixed in separate tubes, so that air can be sucked up between the base of the flames, and those forms in which the nipples are screwed into a flat base do not give such good results, as the air current at the base of the flame is checked, and it is only reciprocal heating which comes into play.

This principle is also made use of in the cluster burners now so extensively used for street lighting, and in these again it is increased air current and increased temperature which leads to increase in luminosity.

My own impression is, that the direction in which to seek for an increase of luminosity in the flat flame is to make it appreciably thicker, and by some convenient arrangement to bring a fairly brisk air current against the flat of the base of the flame. This is of course not easy to do, as you have not an up-draught as in the case of the argand and glass to suck the air in, and if the current were to impinge on the bottom instead of the flat of the flame the loss of light due to distortion of the flame would be equal to, if no greater than, the increase due to heightened temperature. It is manifest from the facts I have brought before you that most of the improvements in our more ordinary burners have been in the direction of "fitting" the burner to the gas, and with any alteration in the quality and illuminating value of the gas, it is also necessary to consider and prove by experiment the best form of burner to obtain from it the highest service.

With an ordinary 16-candle coal gas, it is well known that, amongst simple burners, the London argand gives the best results, but as the illuminating value of the gas increases, this burner ceases to supply air to the flame in sufficient quantity to give the highest service; and with a 20-candle gas we are driven back to a large flat flame burner; and as the percentage of heavy hydrocarbons in the gas increases in quantity, we have to use flat flames of diminishing size, so that with a rich 60-candle oil gas we get the best results with a 00 burner, and if we used a No. 2 we should have a smoky flame of much lower illuminating value.

If a rich oil gas be taken, and a certain percentage of oxygen be added to it, this helps the combustion, and we can burn the mixture at a larger burner than could be used without the oxygen, and in this way, by decreasing the cooling influence of the small burner, we get an increase of luminosity which will, in some cases amount to as much as 25 per cent.; but if we now take this oxy-oil gas and attempt to enrich a poor coal gas by mixing the two together, we at once find that the mixture has a lower illuminating value than if oil gas without oxygen had been used for enrichment, as the amount of hydrocarbons has been reduced to the limit at which the burners themselves can insure sufficient air being obtained by the gas for proper combustion, and the added oxygen lessens rather than increases the result.

Last October, a very interesting series of experiments* were communicated by Mr. A. E. Forstall to the American Gas Light Association, as to the best burner to use with enriched coal gas of a value of 22 candles. He found that for a small consumption of gas the best results were obtained with one of Mr. Sugg's No. 6 table-top governor burners.

In my own mind, I must say the most important reform that can be made in gas lighting is that the gas companies, or other properly qualified authority, should look after the burners in common use amongst their consumers, as the waste of gas due to improper methods of consumption is no gain to the gas company, and is an enormous loss to the consumer, who, in most cases, might obtain double the light he now enjoys at the same cost.

An important question which is constantly before the mind of the gas engineer is, "How far is it possible to go in the generation of light from coal gas, and what is the utmost limit that we are ever likely to attain?"

If we consider this question from the point of view of generating light by the incandescent particles present in the gas itself, we shall find that the regenerative principle is the only road open, unless we can command a supply of free oxygen, and that in the use of regenerative lamps we are tied by the destructibility of the material used in the construction of the lamp. Although it is possible to make a large regenerative burner which shall give a duty of 16 to 17 candles per cubic foot of gas consumed, such a lamp would only last a few hours, and practical experience has shown our lamp makers that the best results obtainable are those which give no more than about 10 candles per cubic foot of gas consumed, but at the same time give lengthened life to the lamp. In fact, our present regenerative burners probably represent the maximum luminosity to be obtained, together with durability of the material at our command, and if greater service is to be obtained from the gas, it can only be got by the use of more refractory material, and even then considerable trouble is sure to arise from the deposition of carbon in the gas supply pipes.

In the generation of light from coal gas only a comparatively small amount of the heat generated by the combustion is converted into light, but a large excess of heat is necessary to complete the actions culminating in the separation of the carbon particles, and any alteration in the composition of illuminating gas which increases the thermal value of the flame without destruction of the thermal particles, will increase its luminosity, and this, I believe, is the cause of some diluents in coal gas being of greater value than others, and affecting the amount of light emitted by the flame less than others; for instance, the work of Dr. Percy Frankland, and my own work of recent date, shows conclusively that methane is the most valuable gas to use for diluting heavier hydrocarbons, whilst hydrogen is far preferable to carbon monoxide.

This latter result has been questioned by some of the apostles of water gas, but I think the following experiments conclusively prove the fact. In these, known mixtures of hydrogen and oil gas were made. The hydrogen used contained 99.6 per cent. of the gas, and the oil was first put into the test holders and the hydrogen then added, every precaution being taken to insure mixing.

Set I.

Illuminating value of the original oil gas.... 49.6 candles.

Percentage of Hydrogen.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
33.3	66.6	34.2	33.0
50.0	50.0	25.5	24.8
66.6	33.3	18.2	16.5

Set II.

Illuminating value of the original oil gas.... 42.8 candles.

Percentage of Hydrogen.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
25.0	75.0	32.8	32.1
50.0	50.0	23.9	21.4
60 0	40.0	21.0	17.1
66.6	33.3	12.4	14.2
71.4	28.5	9.0	12.2

These experiment show that, with hydrogen gas, the illuminating value of the mixture is higher than one would expect from calculation for candle powers higher than 18, but that, when diluted below that

*See AMERICAN GAS LIGHT JOURNAL, Nov. 14, 1892, p. 693.

value, the excessive dilution causes a loss of illuminating power, and so necessitates a larger addition of the enriching gas than that calculated.

Some years ago Dr. Percy Frankland read a paper before the Chemical Society upon ethylene, and his figures reveal the same fact—

Illuminating value of the ethylene ..... 65.5 candles.

Percentage of Ethylene.	Percentage of Hydrogen.	Illuminating Value of the Mixture. Found.	Calculated.
77.55	22.45	54.58	54.28
68 39	31.61	49.37	47.87
53.58	46.42	39.21	37.50
35.47	64.53	30.85	24.82
26.08	73.92	22.84	18.25
13.37	86.63	6.73	9.35

The next combustible diluent experimented with was carbon monoxide, which has an interest for us not only as being the cheapest combustible gas, but also the most poisonous, the numerous accidents which have arisen from the use of water gas being due to its presence.

Illuminating value of the original oil gas.... 54.7 candles.

Percentage of Carbon Monoxide.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated
90	10	Unreadable.	5.4
75	25	8.94	13 6
50	50	21.50	27.3
25	75	38 40	41.0

These experiments show that when even only a small percentage of carbon monoxide is used it has a tendency to reduce the illuminating value of the mixture, whilst in order to make a 17 or 18 candle power gas with carbon monoxide as the basis, a very large excess of hydrocarbon gas would have to be used.

In Frankland's experiments with carbon monoxide and ethylene the results obtained were—

Illuminating value of the original ethylene.. 68.5 candles.

Percentage of Carbon Monoxide.	Percentage of Ethylene.	Illuminating Value of the Mixture. Found.	Calculated.
18 35	81.65	55.27	55.63
32.25	67.75	47.73	46.40
53 70	46.30	33.09	31.71
62.06	37.94	26.52	25 97
71.27	28.73	13.26	19.64
76.11	23.89	6.56	15.86
80.00	20.00	0.00	13.70

Showing an even greater loss of illuminating value in the more diluted mixtures.

Having seen that admixture with hydrogen gives higher results than would be expected, whilst the carbon monoxide seriously detracts from the illuminating value, it might be expected that with water gas—a mixture of the two, theoretically in nearly equal proportions—the one would neutralize the other, and that the results obtained would be nearly proportional to the amount of oil gas used. Experiment, however, shows this not to be the case, the loss in illuminating value being as great as with the carbon monoxide alone.

Illuminating value of the original oil gas.... 54.7 candles.

Percentage of Water Gas.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
90	10	Unreadable.	5.4
75	25	11.9	13.6
50	30	21.6	27.3
25	75	35.6	41.6

These experiments not only show the fallacy of supposing that it is possible to calculate the amount of enriching gas which it is necessary to add in order to attain a given illuminating value, without first taking into consideration the composition of the gas to be enriched, but also give interesting information on the important subject of the carburetting of non-luminous gases.

The varying effect exercised upon the enriching gases by the different diluents is not due to one cause only, but to several acting in unison. In the first place, the illuminating power of a flame is to a great extent governed by temperature. The hotter the flame the more readily are the hydrocarbons broken down and carbon liberated, and the light which this emits being entirely governed by temperature, the hottest flame will always give the most light from any given quantity of hydrocarbons. If we take two flames of equal size, the one obtained by burning hydrogen and the other carbon monoxide, it will always be found that the former is the hottest. Taking a jet of hydrogen 3 inches in height, and a similar one of carbon monoxide, and testing their temperature with a Le Chatelier thermo couple, the hydrogen flame was found to have a temperature of 1,488° C., or 2,610° F., whilst a carbon monoxide flame of the same size gave a temperature of 1,419° C., or 2,554° F.

Another cause is, however, I think, to be found in the fact that as a carbureted carbon monoxide flame burns, a large proportion of carbon dioxide is produced and drawn into the flame, and this in the luminous zone of the flame attacks the liberated carbon, combining with it to form carbon monoxide again, and so uses up some of the carbon upon the presence of which luminosity depends, whilst the high specific heat of the carbon dioxide tends to cool the flame.

The cause of the increased effect produced by enrichment upon a poor coal gas is to a great extent the methane, which forms a very large proportion of the saturated hydrocarbons, and which, although it is practically non-luminous when burnt alone, yet adds considerable to the luminosity of a mixture; also to the hydrogen, more than 50 per cent. of which is present, and which increases the temperature, and, by so doing, the luminosity also; whilst carbon monoxide is only present in coal gas in quantities varying from 3 to 8 per cent., so that its effect upon the luminosity of the flame is entirely overshadowed by the increase due to hydrogen and methane.

Another cause which affects the amount of light emitted by a flame to a greater extent than has ever been fully recognized, is the condition of the atmosphere in which it is burning.

Mr. John Methven, some years ago, found that over a long series of experiments, and with the temperature practically constant, candles gave, per 120 grains of sperm consumed, a light equal to 1.104 as compared with a light of constant power—Methven screen—and that this was increased to 1.196 candles when the air in which the candles were burning was dried. This difference in the light value he considered to be due entirely to the removal of moisture, as the temperature remained the same.

He also found that when dried air was supplied to a flame the amount of light emitted was practically constant, but when air saturated at increasing temperatures is supplied, the light value is rapidly diminished, so that between the temperature of 50° F. and 75° F. a diminution of 10 per cent. takes place in the light emitted by an argand flame burning 5 cubic feet of gas per hour, whilst with a flat flame a reduction of 11.2 per cent. took place, and with a gas flame from a 2-candle burner a loss of 13 per cent. was found within the same range of temperature. The greater loss observed with the flat flame and the small jet, Mr. Methven ascribes to the power of the different flames to battle with the aqueous vapor.

These experiments were made by passing air from a gasholder through a leaden chamber over the surface of sulphuric acid to dry it, whilst to saturate it the sulphuric acid was replaced by water. At the end of the chamber was an upright tower, on the top of which the flame was burning, surrounded in the case of the 2-candle burner by a lamp chimney, and the flat flame by a glass globe.

I have repeated Mr. Methven's experiments in a rather different way, in order, as far as possible, to eliminate any disturbing factors.

I used an open bar photometer, fitted with the burners and disk 14 inches above the level of the table, and cylinders of thin glass, 12 inches in diameter and 24 inches high, were specially made by Messrs. Powell. The tubes carrying the burners rose straight from the photometer table, and carried sliding collars, with four arms to support the glass cylinders. Flat perforated zinc boxes were made to fit into the cylinders, exactly an inch in depth, and were surrounded with soft felt, so as to prevent any air passing up between the cylinder and box; and these boxes, having been completely filled with dry or wet pumice or calcic chloride, as the case may be, the material having been previously sifted to pass through a $\frac{3}{8}$ mesh, but not a $\frac{1}{4}$, will each give very nearly the same amount of obstruction to the passage of the air; whilst, to prevent air entering the top of the cylinder, and to quickly remove the products of combustion, a zinc plate was fitted over each cylinder, with a 2-inch tube, with funnel mouth descending to within a short distance of the top of the flame.

Working with this apparatus, I found, as the mean of many hundred experiments, that a flame, having an illuminating value of 1 candle, had its light diminished by 8 per cent., when the amount of water vapor present in the atmosphere increased 1 grain per cubic foot; whilst, under the same conditions, a 10 candle flame was only affected to the extent of 3.8 per cent., and a 16-candle flame still less.

This being so, it is manifest that, if the illuminating value of a 10-candle flame is being tested against a candle on a day when the air is dry, the one candle will be doing its best, and the illuminating value of the 10 candle flame will appear lower, than on a day when there is a

larger amount of humidity in the air, which, by affecting the small flame more than the large, gives the latter a considerable advantage.

To try how far this showed in actual working, a long series of experiments were made with Mr. Harcourt's one-candle pentane flame against a constant 10-candle standard, both large and small flames, having the air supplied to them dry, normal, or wet, as the case might be. The results are given below:

	Normal.	Wet.	Dry.
Illuminating value of flame	9.95	10.44	9.49
Percentage of saturation	.54	.66	.33
Grains of water per cubic foot of air	7.3	8.0	5.7
Temperature 2 inches below the 10-candle flame	.87	85 8	97.5

Showing a variation of .95 candle for a difference of 2.3 grains of moisture per cubic foot of air, which is equal to an increase in illuminating value of 3.96 per cent. per grain of moisture in the cubic foot of air.

It will, however, be seen that while the temperature in the cylinder is but little higher with dry pumice in the box than with wet pumice, it is 10° higher when the box is filled with calcic chloride.

It was thought that perhaps this alteration in temperature might be due to alteration in the flow of air through the cylinder, and that the secret of variation of luminosity might be in this. To decide this point a delicate anemometer was fitted to the exit tube, and on making the rate of flow identical in each case, the same difference in illuminating power was observed. It was then thought possible that the alteration of the temperature, from whatever cause it arose, might be influencing the amount of light emitted, and instead of the large glass cylinder, a small chamber four feet square was constructed to hold a standard burner, the light of which could pass through thin glass windows in on to the photometer disc, and although no appreciable alteration in temperature could be observed when wet or dry air was used, the alteration in the light emitted remained.

Finally the temperature of the flame burning in normal wet and dry air was taken by the Le Chatelier thermo couple, and it was found that an increase of one grain in the amount of moisture present lowered the temperature of the flame itself nearly 100°, and it is the diminution in the incandescence of the matter in the flame, due to the heat used up in the physical and chemical changes brought about in the flame by the water vapor, which reduces the amount of light emitted.

Dr. Bunte has also made a series of experiments upon the effect of carbon dioxide in air upon the light emitted by flames, and finds that carbonic acid alone may be introduced to a considerable extent without producing any very great effect; but that, when a flame is burnt in a closed chamber, so that the percentage of vapor increases with the carbon dioxide, and the percentage of oxygen is diminished at the same time, then the action upon the flame becomes very marked:

	Carbonic Acid in Air. per Cent.	Illuminating Power in per Cent of Original Power in Normal Atmosphere.	Diminution of Power in per Cent. of Original Power in Normal Atmosphere.
Batswing—			
1	0.26	94.3	5.7
2	0.41	90.6	9.4
3	0.49	87.5	12.5
4	0.54	85.0	15.0
5	0.60	81.7	18.3
6	0.65	80.0	20.0
Argand—			
1	0.18	96.5	3.5
2	0.25	93.7	6.3
3	0.37	84.5	15 5
4	0.43	82.8	17.2
5	0 56	79.7	20.3
6	0.68	77.3	22.7

Results which teach us that proper ventilation is as essential to those processes of combustion which give us light, as to the still more marvellous phases of slow combustion which we call life.

Dr. Bunte, however, comes to the conclusion that the effect of water vapor in air upon the flame is relatively small, a conclusion which the work I have brought before you certainly disproves.

The effect of inert gases upon the luminosity of flame may be looked upon partly as one of dilution, and therefore reduction of the quantity of oxygen present in the air in which the flame is burning, and partly cooling of the flame, by physical and chemical actions taking place when the water vapor or carbon dioxide is drawn into the flame itself.

An idea of the extent of this may be obtained by studying the effect of various diluents upon coal gas, burnt in a form of burner in which the flow of coal gas and diluent could be accurately controlled.

Volumes of Gases Required to Render 1 Volume of Coal Gas Non-Luminous.

One volume of gas requires—

0.5	volumes of	oxygen.
1.26	"	carbon dioxide.
2.27	"	air.
2.30	"	nitrogen.
5.11	"	carbon monoxide.
12.4	"	hydrogen.

Showing that a diluent which burns and adds to the general temperature of the flame must be added in far greater quantity than an inert and non-combustible diluent such as nitrogen, a result fully borne out by experience.

Some observers have attributed the varying effect of diluents to the effect of density, but the destruction of luminosity in a flame can be brought about by cooling as well as by dilution.

It is evident that this being the case, if one diluent has the power of abstracting more heat from the flame than another, it will be more active in reducing the luminosity, and a smaller quantity will be required to render the flame non-luminous. And on comparing the specific heats of equal volumes of the diluents used in the last experiment, the reason for the small quantity of carbon dioxide is at once seen.

Specific Heats of Equal Volumes.

Oxygen	0.2405
Carbon dioxide	0.3307
Nitrogen	0.2370
Air	0.2374
Carbon monoxide	0.2370
Hydrogen	0.2359

If this be the true explanation, then it should be easy to trace the action by the decrease in temperature of the flame when carbon dioxide is used to render it non-luminous.

In order to take the temperature of the inner cone of the flame by means of the thermo-couple before described, it is manifest that the wires, even when protected by glass, must not pass through the outer zone, as with some mixtures of coal gas and air the heated platinum would set up rapid combination on its surface. To overcome this difficulty the wires, insulated with glass, were passed up the interior of the burner tube, and the gas supply was kept constant at 6 cubic feet per hour, whilst the diluents were supplied under pressure at the same rates as before determined, and the following results were obtained:

Temperature of Flame from Bunsen Burner, with Consumption of 6 Cubic Feet of Coal Gas per Hour.

Point in Flame.	Flame Rendered Non-Luminous by Air.	Nitrogen.	Carbon Dioxide.	Luminous Flame from Bunsen.
½ inch above burner	54°	30°	35°	135°
1½ inch above burner	175°	111°	70°	421°
Tip of inner cone	1,090°	444°	393°	913°
Center of outer cone	1,533°	999°	770°	1,328°
Tip of outer cone	1,175°	1,151°	951°	728°
Side of outer cone level with tip of inner cone	1,333°	1,236°	970°	1,236°

Results which fully bear out the inferences derived from the behavior of the flames in the former experiments. In the flames rendered non-luminous by diluents, the inner cone for the first 1½ inches is decidedly cooler than in the luminous flame, owing to the cooling action of the nitrogen or carbon dioxide, in the upper portion of the inner cone of the flame rendered non-luminous by air, however the oxygen of the air is acting, and the temperature is therefore higher than in the luminous flame, whilst in both the hottest portion of the flame is almost half-way between the tip of the inner and outer cones.

In flames rendered non-luminous by inert diluents, this is not the case, as the full amount of air necessary for combustion only being obtained at the side and tip of the outer cone, these are the hottest points.

The low temperature registered at the tip of a luminous flame is probably due to the impossibility of keeping that portion of the flame steady when the gas is burning from a bunsen with the air supply closed.

Experiments with a bunsen, burning a mixture of air and coal gas in such proportions as to give the green inner cone, showed that although the excess of air caused a low temperature of the bottom of the inner cone, the increase in rapidity of oxidation due to excess of oxygen, c used a rapid rise of temperature, and a hotter and smaller flame was the result.

	Blue Inner Cone.	Greenish Inner Cone.
Tip of inner cone	1,090°	1,575°
Center of outer cone	1,533°	1,630°
Tip of outer cone	1,175°	1,545°
Side of outer cone level with the tip of inner cone	1,333°	1,511°

These experiments, as well as the researches of Heumann, show that oxidation, dilution and cooling all help to bring about the destruction of the luminosity in a bunsen flame.

I have now gone as far as the limited time at my disposal would admit, into the theories and facts which we can glean with regard to the luminous combustion of a coal gas flame, and I must confess that my own feeling is one of disappointment at not having succeeded in crowding more into the four hours I have been privileged to be with you, and in concluding, can only hope that you will take the will for the deed, and if the performance has been poor, remember that the desire has been to do the fullest possible justice to the subject and the workers who have elucidated it.

Further Applications of Coal Gas for Heating.

Mr. Thomas Fletcher, F.C.S., of Warrington, England n mentioning some of the directions in which he has been a pioneer in the instance of the application of gaseous fuel for heating, says:

I have repeatedly had to deal with the problem of heating large beer-bottling stores for conditioning bottled beers; and the experience obtained is valuable for other purposes. No bottled beer would be saleable, either in this country or abroad, unless it is sufficiently charged with carbonic acid gas. The quantity held by the beer in cask is insufficient to produce a satisfactory "head," and the simplest method of obtaining the required condition is to promote fermentation in the beer after it is bottled and corked. For this a steady temperature of 57° F. is desirable. My earlier attempts have been fairly satisfactory. But the difficulty has been to make the bottlers understand the necessity for carrying out details correctly; and I have never, until recently, been able to obtain an exact and scientifically conducted test which would put the matter on a proper basis. This has at last been done in the bottling stores of Sir Andrew Walker & Sons, Limited.

In my own experience it has been proved repeatedly that, for work of this class, where diffused heat, sometimes exceedingly small in amount, is required in large spaces, the best burners are ordinary lighting jets placed as near the floor as possible, in rows on an ordinary gas pipe; the jets being from 7 to 10 feet apart. With regard to the position of the burners for equal temperatures, the smoke test, verified by a series of exact experiments in plant-house heating, proves conclusively that any irregular distribution of the sources of heat causes eddying currents and great irregularities. In one case a difference of 8.5° F. between two points 6 feet apart has been observed.

The position of the burners indicated by these experiments is one or more straight lines, which, by causing an upward current, induce a corresponding descending one at the part of the room farthest away from the burners. The rooms where the tests were made are three in number—all adjoining each other—the sizes being as follows:

91 feet long.	23 feet wide.	8 feet high.
20 "	19 "	8 "
22 "	20 "	8 "

The total wall surface was 3,000 square feet, and the window surface approximately 100 square feet. In the largest room seven brewers' standard thermometers were used.

Owing to the arrangement of the contents, it was found most convenient to run two 1-inch iron pipes on the floor near the center from end to end, with the necessary breaks for cross traffic. In these are screwed, at every 8 feet, one No. 2 Bray's union-jet burner, and each pipe is controlled by a 1-inch gas tap, with lever arm and quadrant for exact adjustment. The thermometers were placed as follows:

A, 5 ft. 6 in. from floor, 6 ft. from nearest burner.
B, 3 " 8 " " 6 " " "
C, 7 " " 6 " " "

No. 1, near the door, at 11 ft. from nearest burner.
" 2, center of the room, 1½ ft. from nearest burner.
" 3, center of the room, 7 ft. from nearest burner.
" 4, end of the room, 11 ft. from nearest burner, and 7 ft. 6 in. from No. 1.

All adjustments of the gas were made by hand on an ungoverned service, and the following gives a week's readings:

Daily Temperature, in Degrees F., from Nov. 1 to Nov. 7, 1892.

Thermometer.	6 A.M.	Noon.	6 P.M.
No. 1	58	58	59
" 2	58	57¾	59½
" 3	59	58½	60
" 4	58	56½	59
Outside	—	45	34
No. 1	57½	58	60
" 2	57½	57¾	60
" 3	57½	58	60
" 4	57½	57½	58½
Outside	40	44	45
No. 1	58½	58	58
" 2	58½	59½	60
" 3	58½	50	58
" 4	57½	58	58
Outside	46	55	49
No. 1	57½	Not taken.	56
" 2	58	"	56
" 3	58	"	56
" 4	58	"	56
Outside	51	"	55
No. 1	57½	57	Not taken.
" 2	58½	58	"
" 3	58	58	"
" 4	57½	57	"
Outside	51	51	"
No. 1	56	56	57
" 2	56½	59	59
" 3	55½	58	58
" 4	55	58	58
Outside	45	46	42

Thermometers A, B, and C, vertically over each other, were respectively 7 inches, 3 feet 8 inches, and 5 feet 6 inches from the floor in a room 8 feet high. In six out of 16 readings the difference between the three did not exceed 1° F. The greatest difference was 3°, and it occurred in only one reading. So that, for all practical purposes, the heating of the room vertically may be considered perfect. The most striking point is the extreme uniformity of heat obtained by hand regulation during excessive changes outside. The total gas consumption for heating the three rooms was taken twice. With an outside temperature of 19° F., the consumption of gas was 100 cubic feet per hour; with an outside temperature of 35° F., the average was 50 cubic feet per hour.

In the two smaller rooms a center tube was impossible, and the only available method was to put a pipe with union jets along one wall, near the wall and the floor. One end of the pipe was turned to run along the next wall for about 6 feet. This, I think, is a mistake; and further trials will be made without this extra length. A break in the straight line of jets evidently causes eddying and irregular currents. As a proof of this, the reading of the thermometer 2 feet 6 inches from the end flame was 56° F. in the center of the room, and 58° F. 10 feet from the nearest flame.

Taking the whole result, I found that, with a wall surface of 3,000 square feet, and windows 100 square feet, a gas consumption of 100 cubic feet per hour will maintain a rise of 39° F., which will give approximately the following rough rule: 1 cubic foot of gas burnt per hour will maintain a rise of 1° F. in a room having 1,200 square feet of wall surface, if burnt in a common lighting burner near the floor, with very limited ventilation and good brick walls. My method of calculating by the wall surface is, I believe, the only one which is of any value in this class of work, as practically the whole of the loss is through the walls. The amount expended on heating the air is exceedingly small in any case where the ventilation is limited; and it must be very clearly borne in mind that the gas consumption given is only the quantity necessary to maintain the temperature after the correct heat has been obtained by steady heating day and night, until the inner wall surface corresponds in temperature with the air in the room.

As a maker of atmospheric burners, this would appear to be a matter outside my own special department; but it is one of very considerable interest to gas engineers, and therefore, if not directly advantageous to myself, is worthy of careful consideration, as showing the simplicity, perfection and cost of exact work on a fairly large commercial scale. There is no doubt whatever that the steady temperature obtained would be impossible with any system of steam or fire stove heating, and would be very difficult, even if possible, by hot water pipes. If steam were used, the heating of the pipe would be very irregular, unless working at full power; and the accumulated heat in hot-water pipes would prevent the rapid adjustment required for the great outside variations that constantly occur.

The Transformation of Heat Into Permanent Chemical Energy in the Production of Producer Gas and Carbonic Acid Producer Gas.

By Herr A. Naumann.

Three methods are chiefly available for the transformation of coal into heating gas: the production of illuminating gas by destructive distillation of coal, that of water gas by the action of steam or the elements of water on heated fuel, and that of producer gas or carbonic oxide from coal supplied with air.

In the production of illuminating gas only a small fraction of the heat energy of the coal is transformed into gaseous fuel. The relatively high price of this gas prevents its application on a large scale as a heating gas; on a small scale it is employed for heating purposes and motive power in the absence of a cheaper gaseous fuel, and because it can be obtained in all large towns.

The formation of water gas is endothermic; heat is absorbed according to the thermochemical equation:

$$H_2O \text{ (liquid)} + C = H_2 + CO \quad . \; . \; . \quad -38{,}770 \text{ calories.}$$

The somewhat complicated apparatus required for the production of water gas only allows of its preparation with advantage on a large scale, but in that case the advantage is so considerable that in the towns of North America water gas has been substituted, to a great extent, and sometimes altogether, for illuminating gas for lighting purposes, its lighting power being obtained by so-called carbureting.*

The production of producer gas is comparatively simple and easily carried out. The formation of producer gas is exothermic; it liberates heat.

$$C + \frac{O + 53.6 \text{ parts by weight of nitrogen}}{\text{air}} = \frac{CO + 53.6 \text{ parts by weight of nitrogen}}{\text{producer gas}} + 29{,}690 \text{ calories.}$$

The amount of heat here indicated causes the theoretical temperature of producer gas at the moment of its formation to be 1,446° C., assuming that the specific heats of its constituents are the same at high as at ordinary temperatures. The heat of formation (29,690 calories) thus indicated is utilized if the gas be consumed on the spot as fast as it is produced, but is lost if the gas is conveyed to any distance, or stored and allowed to cool to the ordinary temperature of the air, 15° C., the amount of heat then available being only that evolved by the combustion of the carbonic oxide in the gas—that is, 67,960 calories. Out of a total of 97,650 calories available, only 67,960 calories would be utilized in the latter case, corresponding to a waste of 30.4 per cent. of the theoretical quantity of heat available.

Two methods are within our reach for converting into permanent chemical energy the quantity of heat appearing in the form of high temperature in the producer and incorporating it in the gas.

Either so much water may be introduced into the producer with the air as to absorb from the heat generated (+ 29,690 calories) by being decomposed in contact with the fuel, thereby producing hydrogen and carbonic oxide, which mix with the ordinary producer gas generated at the same time, enriching it and forming a heating gas, which may be called water producer gas; or carbonic acid may be similarly introduced into the gas producer to form carbonic oxide, which mixes with the ordinary producer gas, generated at the same time, forming a heating gas which may be called carbonic acid producer gas.

In the following tables for each of these two heating gases the composition, heat of combustion, rise of temperature of the flame, and heat given up by the products of combustion for a reduction of 1° in temperature are compared with the corresponding amounts for producer gas. I may here mention that the method of procedure for determining these values is tedious and troublesome, and I therefore limit myself to tabulating the results.

The composition of water producer gas from fluid water at 15° and gaseous water at 15° is calculated from the following thermochemical equations II. and III., and that of carbonic acid producer gas from equations I. and IV.

$$\text{I.} \quad C + \frac{O + 53.6 \text{ parts by weight of nitrogen}}{\text{air}} = \frac{CO + 53.6 \text{ parts by weight of nitrogen}}{\text{producer gas}} + 29{,}690 \text{ calories.}$$

$$\text{II.} \quad H_2O \text{ (liquid)} + C = \frac{H_2 + CO}{\text{water gas}} - 38{,}770$$

$$\text{III.} \quad H_2O \text{ (gaseous at 15°)} + C = \frac{H_2 + CO}{\text{water gas}} - 27{,}970$$

$$\text{IV.} \quad CO_2 + C = 2\,CO - 38{,}270$$

In the following tables are given separately, firstly, the volumes of the gases formed and mixed in the producer and of the water gas which together form water producer gas: and, secondly, the volumes of the chemical constituents of those gases; for carbonic acid producer gas the volumes of the producer gas and the carbonic oxide formed by the reduction of the carbonic acid introduced into the producer are first given, and afterwards the volumes of the chemical constituents of those gases.

I.—Composition of producer gas from pure carbon:

Carbonic oxide	34.3 per cent. by volume.
Nitrogen	65.7 " "
	100.0

II.—Composition of water producer gas:

		From Liquid H_2O at 15° —Percentage by Volume—	From Gaseous H_2O at 15°
1.	Producer gas	65.55	57.9
	Water gas	34.45	42.1
		100.00	100.00
Equivalent to—			
2.	Hydrogen	17.2	21.1
	Carbonic oxide	39.7	40.9
	Nitrogen	43.1	38.0
		100.0	100.0

III.—Composition of carbonic acid producer gas:

		Percentage by Volume.
1.	Producer gas	65.3
	Carbonic oxide made from carbonic acid and carbon	34.7
		100.0
Equivalent to—		
2.	Carbonic oxide	57.1
	Nitrogen	42 9
		100.0

A glance at the above volume percentage composition of the three heating gases shows at once the superiority of water producer gas and of carbonic acid producer gas over ordinary producer gas. This superiority is shown still more clearly by a comparison of the following values: 1. The heat of combustion of a liter of each gas calculated from the above composition and the known heat of combustion of their constituents. 2. The rise of temperature of the flame calculated from the temperature of combustion and specific heat and quantity of gases existing after combustion. 3. The heat given off by the products of combustion of a liter of gas by reducing the temperature 1°.

For comparison these values are also calculated and given for water gas, it being assumed that combustion in all cases is effected with only the quantity of air theoretically necessary.

Heating Gas.	Heat of Combustion of 1 Liter of Gas, the Water Produced being Assumed to be Gaseous at 15° C.	Rise of Temperature of Flame.	Heat Units Given up by the Products of Combustion from 1 Liter of the Gas in Cooling 1°.
1. Producer gas	1,044 calories.	1,904°	0.5487 calories.
2. Carbonic acid producer gas	1,739 "	2,449°	0.7101 "
3. Water producer gas from liquid water at 15°	1,652 "	2,356°	0 7016 "
4. Water producer gas from gaseous water at 15°	1,790 "	2,431°	0.7363 "
5. Water gas	2,812 "	2,830°	0 9934 "

The above changes of sensible heat into permanent chemical energy, which have been theoretically and experimentally determined, have also been applied in practice.

The so-called Dowson gas* is technically water producer gas, where for its production air and steam are introduced together into the hot fuel. The values for the steam only vary slightly from those given above for water at 15°, as the difference between the heat of evaporation of water at 15°, and at higher temperatures is but slight. Such water producer gas had, according to Dowson's† own data, the following com-

* Hence my opinion as regards water gas expressed more than ten years ago in the last sentence of my paper, "The Question of Heating with special reference to the Production of Water Gas and Heating by Water Gas" (Giessen J. Ricker's Library, 18 1, page 90), has been proved correct: "and where the theory indicates such favorable prospects its practical application should follow."

* *Journal fur Gasbeleuchtung*, 1881, page 674. German patent No. 27,165; see Wagner Fischer, "Jahresber. Chem. Tech.," 1887, pages 189 to 193. In 1885 Dowson gas had already been frequently used in England for heating, melting and motive power. But water gas can also be used, at least in those cases in which it can be burnt on leaving the producer. See T. A. Jahn's separate print, "Two Furnaces Worked by Illuminating Gas, etc.," Prag, October, 1881, published by the author. Later still, J. Quaglio referred in his paper, "Water Gas as the Fuel of the Future," Wiesbaden, 1889, page 23, to the use of water producer gas, but has more recently shown it to be impracticable on account of the amount of nitrogen. In the Frankfort Electro-Technical Exhibition, 1890, a water gas producer was set up to drive a gas motor of 60-horse power in the machine hall, which was coupled with a dynamo used for charging the secondary battery in the theater.

† Wagner Fischer, "Annual Chem. Tech.," 1887, page 171.

position, I.; another, according to a paper of Schilling,* has the composition II.

Constituents.	In Volumes per Cent. I.	II.
Hydrogen	18.73	17
Carbonic oxide	25.07	23
Methane	0.31	2
Ethylene	0.31	—
Carbonic acid	0.57	6
Nitrogen	48.98	52
Oxygen	0.3	—
	100.00	100.0

The discrepancies in the composition of theoretical water gas and of that used in practice are explained by the consideration that the latter contains carbonic acid, which, if completely reduced, would give double its volume of carbonic oxide, and that pure carbon is assumed to be used in the formation of theoretical water producer gas in the above calculation.

In Dowson's arrangement the excess heat of production of the producer gas is actually transformed into the chemical energy of water gas, produced by the simultaneous introduction of air and steam into the producer, and their decomposition by the coal, which, being added to the producer gas, forms water producer gas.

In the new form of Siemens furnace the same *modus operandi* is partially carried out; steam is also blown into the producer, and besides this a portion of the products of combustion is led into the producer at a high temperature. As these products of combustion contain steam as well as carbonic acid, both water gas and also carbonic acid producer gas are formed. The sensible heat is here converted into chemical energy by the conversion of steam into water gas ($H_2O + C = H_2 + CO$), and the CO_2 into CO ($CO_2 + C = 2CO$), the result being an increase of the hydrogen and carbonic oxide in the gas made. To produce water gas from steam and hot carbon without any extraneous heat, the steam would have to be introduced at the temperature of 3,230°. To produce carbonic oxide from carbonic acid and heated carbon without any extraneous heat, the carbonic acid would have to be introduced at a temperature of 4,008°. However, the nitrogen contained in the hot products of combustion carries with it a considerable amount of heat, which is available for the above-named processes of conversion. But the introduction of relatively large volumes of nitrogen contained in the products of combustion into the gas producer, and thus going into the heating gas produced, prevents the total utilization of the products of combustion in this manner. Therefore in the new-form Siemens furnace not more than half the products of combustion are returned to the gas producer. The theoretical limit of this amount depends upon the temperature of the returned products of combustion, also on their composition, as per table below, assuming that only the theoretical amount of air required for perfect combustion is used and taken with reference to the calorific and other values given above for one liter of producer gas, water producer gas, carbonic acid producer gas, and, for comparison, also water gas.

Weights of products of combustion, in grammes, in one liter of theoretical heating gas:

Heating Gas.	Products of Combustion, in Grammes. CO_2.	N.	H_2O.
1. Producer gas	0.6762	1.6474	—
2. Water producer gas from gaseous water at 15°	0.806	1.965	0.171
3. Carbonic acid producer gas	1.125	1.909	—
4. Water gas	1.064	3.207	0.504

According to scientific observation, these are the highest results which can be attained theoretically for converting sensible heat into chemical energy for water producer gas and carbonic acid producer gas. A comparison of these with the results already obtained in practice would be a guide as to how far the heat in various fuels can be utilized to the best advantage, and so avoid errors in treating fuel.

* R. Riedermann, "Chem. Tech. Annual," 1889-90, pages 12 and 206.

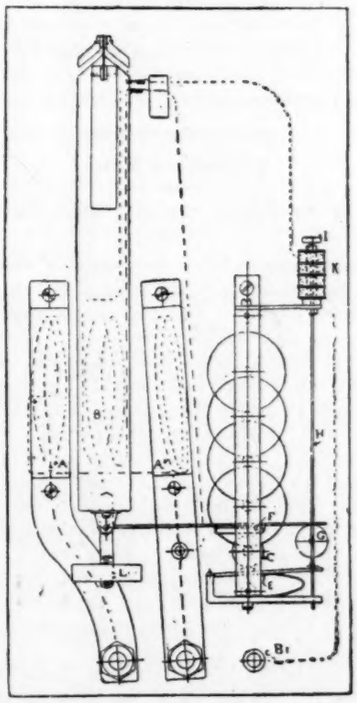
Scott's Electric Meter.

The illustration shows the working parts of an electric meter, the manufacturers of which are Messrs. Lawrence Scott & Co., of Norwich, England, and as the construction is quite simple the cut gives a very good idea of the apparatus and the principles on which it is based.

In the illustration *A A* represents the fixed series coils of strip copper through which the current flows to the lamps; *B* is the movable shunt coil, which has a resistance of about 1,500 ohms, and is connected with the special meter wire by its terminal B^1; *C* is a friction roller geared to the indicating train; the brake *E* prevents the friction roller from being moved otherwise than by the proper action of the meter; the friction pad *F*, when lowered on to *C*, communicates to it, and thus to the train, every movement of the suspended coil *B*; *G*, the roller on vertical carrier *H*, is lowered when the armature *I* of the little magnet *K* is attracted, and *L* is the adjusting weight.

Originally, a self-winding clock was included in each meter, but this made a somewhat complicated and expensive instrument of it, and by dispensing with the clock in each meter, and using one clockwork apparatus in a central position to control the timing of a whole lot of meters, a simple and practical system is made, which, notwithstanding that a special meter wire has to be laid with the supply mains, is, in most cases, cheaper than the ordinary system of meters.

The meter wires, in connection with the shunt terminal B^1, are periodically connected up to the lighting mains by the clockwork, or by a relay operating therefrom, so that shunt currents are periodically



sent through the suspended coil, and the little magnet coil pulling the pad *F* into gear with the friction roller, thus communicating the forward movement or "deflection" of the suspended coil to the friction roller. This movement is exactly proportioned to the current flowing in *A A* when the difference of potential at the shunt terminals is constant. When the central clockwork apparatus breaks this shunt current the friction pad is lifted from the roller *C* before *B* commences its backward movement, so that the indicating train is moved only in one direction, and the various forward movements of *B* are integrated on it. These meters have been found to have an accurate range of over one hundredfold, which could, if necessary, be very much exceeded. They work on the most accurate known principle, and careful experiments have not revealed any error in the application of the principle to these instruments.

As a rule, the meter is arranged to give accurate readings in Board of Trade units, when the shunt circuit is completed every 90 seconds. The shunt current remains on for about 12 seconds. The central clockwork is so arranged as to make contacts one after the other with six separate circuits of meter wires, and as the resistance of the shunt circuit of each meter is about 1,500 ohms, there can be 45 meters on each circuit, or 270 meters altogether, worked with a total shunt current of three amperes. so that a 7-20 or 7-18 cable is quite large enough for the main meter wires, one branch wire of 3-22 being carried from the meter main to each meter in the premises of the consumer. A relay for long distances and large numbers of meters can easily be arranged in a junction box, which connects the next length of meter wire with the mains synchronously with the first length. The expense of the special meter wires required for this arrangement is more than balanced by the simplicity and consequent cheapness of the meter itself.

If, instead of sending a shunt current into the meter once in 90 seconds, the interval is increased to 180 seconds, the meters indicate only half the current used. The central clockwork can be arranged so that the alteration can be easily effected, and if the alteration from a 180-second period to a 90 second period is made, say, an hour before sunset by the almanac all the year round, and back again at some fixed time during the evening, it is evident that during ordinary working hours in summer, and during the greater part of them in winter, the current will be supplied at half price, making the cost of power from electric motors compare favorably with that from gas engines. This will also pay the supply companies, as, if they were not supplying the current during these hours, their plant would be standing almost idle.

Nor will this "power" load overlap the "lighting" load, as the current during this time will be paid for at lighting rate, and there will be many instances where consumers will arrange not to use power at those hours, so as to avoid the higher rate. It will also encourage the use of electric power during the summer time, as many manufacturers have steam power they would gladly stop during the summer months, but prefer to run it in the winter and utilize the waste heat for warming their premises. The shunt currents can easily be made to record themselves on suitably arranged paper, marked with the time of day, by which means the records can be examined and checked as often as desired.

The Edison Meter.

[A paper read by Mr. John F. Gilchrist before the Chicago Electric Club.]

With the first appearance of electricity upon the market of the world as a commercial commodity came the demand for an electricity meter. Business men were interested and enthusiastic over this new force which was attracting the attention of so many of their scientific brethren. They were anxious to see it developed, and to assist in procuring the benefits which would result to the world; but when the time came to offer it to them as an article of commerce, something to assist them in their business, and for which they must pay, they were none the less exacting. If electricity was on the market to be bought and sold as merchandise, there must be some way devised to measure it, or placing it in some tangible form, so that it could be transferred from one to another for a price, so that buyers would know whether they were getting the full worth of their money or not. Here was a hard nut for the electrical men to crack—but crack it they must, for all the plans for doing business without a means of exact measurement were showing defects and proving unsatisfactory both to producer and consumer. A meter must be devised.

Naturally, in their labors in this direction their first thoughts were something like this: In what ways does this current make its force known which are subject to control and observation? By what facts can an idea of its force be estimated? It creates heat in conductors, it excites magnets, it decomposes water, and, by combined chemical and mechanical application of this last law, it will deposit metal from one plate or electrode to another. This last-named action of the current, known as electrolysis, was the one with which it was most easy to experiment, and it was soon found that the quantity of metal deposited by a given current in a given time was constant, and that the amount of current was accurately measured by the weight of metal deposited. Here, then, was something to work on, and from which has come the electrolytic meter—a meter for continuous current of constant potential, in which the amount of current passed is determined by the weight of metal deposited on small plates submerged in a metal solution by the electrolytic action of the current.

When the first experiments were made with the chemical meter the entire current to be used was conducted through the measuring bottles, but this was soon found to be not only impracticable, but unnecessary, and a high resistance circuit, of which the measuring bottle formed a part, was connected in shunt with the main line, so that only a small percentage of the current measured was conducted through the bottles.

Numerous experiments have proved that absolutely accurate measurements can be obtained, even in cases of very small amounts of current, by passing a $\frac{1}{1000}$ of the entire current through the measuring bottles, and from that up to $\frac{1}{14000}$ in the case of heavy currents.

In theory this might be carried out to infinity, and even in practice to a much smaller amount than already indicated, if the most favorable conditions of operation could always be relied upon, but under ordinary conditions it is unsafe, for the obvious reason that any slight increase of resistance which may occur in the bottle shunt creates an error which is greatly magnified in the main circuit. The change referred to was made before the meter was put into practice, and no radical changes have been made since. With the exception of small details of construction intended to facilitate operation, the meter is the same to day as when first brought out.

The first Edison meters constructed were made of tin—shallow rectangular boxes designed to be fastened upon the wall. The boxes were provided with hinged doors of the full size of one side of the meter. The meter was divided by a shelf into two equal compartments. In the lower space were placed the heavy conductors, extending from one side to the other. The ends of these conductors were set in binding posts made to admit and secure the main circuit wires. To these binding posts the small wires of the shunt circuit were fastened. This smaller circuit included a resistance coil and the measuring bottles, the latter being connected in circuit by flexibles provided with binding posts at the loose end to be fastened to the rods of the electrodes in the bottles.

Operation proved that improvements could be made. The metal case, which demanded great care in insulation, and which also proved too flimsy to stand the work, was discarded, and a substantial wooden case somewhat larger took its place. The flexible connections for receiving the measuring bottles required too much time to adjust, and also had the bad habit of getting their heads together and short circuiting the bottle, or, worse yet, getting mixed with the opposite pole and putting out the customer's lights, so that in these new meters metal clips or strips of spring copper were substituted, fastened to the back of the meter and projecting forward in a way which admitted of being sprung up and down, but rigid as regarded lateral motion, and were placed just far enough apart so that the ends of the bottle electrodes could be placed beneath them and thus close the circuit when the bottle itself stood upon the meter shelf.

The three-wire type of this meter is simply two two-wire meters placed in the same case; the two left-hand bottles measuring the current of the upper outside wire and the two right hand measuring for the lower one. The two bottles on one side are wired in multiple with each other, and the circuit is thus formed in multiple with the main conductors; thus the two bottles should read the same, one acting as a check upon the other. The resistants used in these meters are small coils of copper wire varying in resistance according to the size of the meters, or rather the size of the main conductors, so that the ratio of resistance of the bottle circuit to the resistance of the main circuit is the same in all sizes of meters, namely, as 1 is to 974. The measuring bottles resemble a patent fruit jar in appearance, having a glass cover provided with two small holes for the rods of the electrodes and held in place by metal screw rings, while a rubber gasket and small corks fitting over the rods into the holes in the cover prevent the fluid from spilling or evaporating. Each bottle is equipped with a pair of plates or zincs, small rectangular pieces stamped out of ¼ inch metal and having a copper rod screwed into one end for the purpose of making contact. These plates are provided with small holes, through which pass the rubber bolts which fasten the pair together, while small rubber fittings prevent their coming into actual contact with each other. The bottles are filled so that the zinc portion of the plates is entirely submerged with a light solution of zinc sulphate. These bottles and plates vary in size according to the amount of current they are designed to measure. The smallest ones are constructed to measure a three ampere current, holding a quarter of a pint of fluid and the plates having an electrolytic surface about ¼ square inch. From this they increase in pressure by geometrical progression, the largest bottles holding over a quart of fluid and weighing, when prepared, five pounds.

This is the meter which is most largely used in Edison stations to-day, and is very satisfactory, with the single exception of being quite expensive to operate. The last meter brought out by the Edison people, known as the standard meter, has still further lessened the labor of operation, and would be more generally used were it not for the fact that it is constructed to use a heavier solution, so that it is not wise to use it with the old meter when all are operated from the same room, as a chance for error is created by getting the solutions mixed. In this meter the bottles are placed in the lower part of the meter, which is an improvement over the old style for several reasons; the fluid from the broken bottle cannot drip into the zigzag of the main conductor, and thus eat it out by the action of the current; there is less danger of the meter man making an accidental short circuit on the main wires if he is not obliged to reach up over them in changing bottles, and as meters are generally placed above a man's head they are easier to read. But the change which most facilitates operation is the use of one size of bottles in all meters. This is accomplished by varying the ratio of resistance between the main circuit, and the bottle shunt in the meters of different capacity.

Whereas in the smallest meter the ratio is that of 1,223:1 and a deposit of one milligram on the plates means that one ampere hour of current has passed on the main wires, in the largest meters the ratio is that of 9,784:1, and one milligram on the plates means that 8 ampere hours of current have passed in the main circuit; this of course requiring a different constant for each size of meter when making out bills.

In this meter the bottles are about the size and shape of a whiskey glass, and have a large cork instead of a glass cover, and rings of the old style bottle, by which much labor is saved.

The plates also are something of a departure in size and shape. When this meter was brought out the confidence in the chemical meter had become so great and the system of bottles in multiple used in checking showed so little variation from absolute accuracy that the second bottle in the smaller size of meter was deemed unnecessary, and was discarded.

Aside from these changes the meter is the same as before, being made in about the same sizes and of the same material. In the Edison meter everything depends upon operation, and in order to operate well the first and greatest requirement is one which has not up to the present time been fully appreciated, namely, a spacious and commodious meter room, well provided with necessary apparatus and furniture, good light and all the red tape and system in the matter of handling that can be used.

For the sake of getting an idea of the necessary work and care let us follow a set of meter bottles through the mill. The zinc plates are first ground in order to clean and brighten the surface. For this a sand paper is used, run by a motor; then the tops and joints between the plates and rods are carefully painted with asphalt varnish to protect the point from the action of the mercury. After grinding and painting the plates are amalgamated, then brushed off carefully with a stiff nail brush or, better yet, a revolving brush, and placed in a rack to dry over night.

When the mercury is thoroughly dry the plate is found to be covered with crystals of mercury. These must be removed before weighing. This is done by polishing them on a scratch wheel or steel buff, which removes the crystals and leaves a clean smooth surface. The plates are then wiped off with a clean crash towel to remove dust and particles of mercury and are turned over to the scale man to be weighed.

The scales used for weighing plates are the finest assayers' balances, laboratory style, and will weigh to $\frac{1}{10}$ of a milligram. Here the plates are weighed, each one having attached a tag bearing the name of the consumer, the weight of the plate, and a letter designating the position of the bottle in the meeting. Only one plate in each bottle is weighed. The plates are then made up, that is, fastened together by rubber bolts, placed in the bottles, which are filled with fluid and the covers adjusted, the bottles sorted into sets and placed in cases, ready to be carried out to the meters. In putting the bottles into the meters the only care necessary is to see that good contact is made between rod and clip, and that the bottle is so placed that the weighed plate in each bottle shall come under the positive pole, and thus become the losing plate. This is really immaterial, as the theory that one plate gains the exact amount that the other loses is well established in practice, but it is well to have some system, and in occasional cases where the deposit is not firm, having been deposited very rapidly, it is better to have the positive plate, as nothing but current will loosen the firm new zinc of the losing plate, while the crystals of the gaining plate may be removed by abrasion due to careless handling. The new bottles having been put in place, and the meter resealed, the old bottles taken from the meter go into the case, are returned to the meter room, knocked down—that is, plates removed from bottles and taken apart—and are put into racks to dry. When dry, plates are again weighed, the weight being entered upon customer's record directly beneath the weight of the same plate when it left the meter room the previous month; then, having accomplished their mission, they are sent to the grinding room to go through the same form for some other meter the following month. Meter plates in ordinary use will last from six to eight months, when they become thin and small and go to the scrap pile.

Between the losses of plate from multiple bottles an average is taken, and from this the bill is easily figured, using for convenience a previously figured constant. The action which takes place between plates when current is passed through the bottle, and upon which the entire system is based, is the same as that employed in electroplating. As we say in explaining to customers, it is a chemical action, which amounts practically to deposit of metal from one plate to the next. The exact action is this: A molecule of zinc sulphate solution is decomposed at the negative electrode; the zinc in the molecule immediately adheres to the zinc plate, while the other elements seize upon the zinc of the molecule behind, and toward the other plate, and form a new molecule; this action keeps up throughout the distance from one plate to the other until the freed element of the last molecule seizes upon an atom of zinc from the positive plate, and the chain is complete.

This action is very slow, and, of course, entirely invisible, but extremely sure. Occasional cases will occur when on account of overloading the deposit will not be good, but they are safe, and are taken care of by the use of the second bottle.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

A CONCERN known as the Colorado Electric and Gas Company, which is to exploit its business in Denver, Colorado, has been incorporated by Messrs. Owen Allen, W. H. James, and H. C. James. It is capitalized in $500,000.

A WELCOME visitor the other day was Mr. Edward F. Sherman, who looks to be a worthy son of his father, Mr. F. C. Sherman, the mention of whose name naturally brings to mind the New Haven (Conn.) Gas Company, to the service of which, as its works Manager, Mr. Sherman has given many fruitful years. Mr. Edward F. Sherman recently returned to his home from a two years' stay in Europe, whither he went to complete his training; and most of his European residence was given to study in the Leipsic University, under the immediate tuition of Professor Ostwald, recognized in Germany as an expert in gas chemistry. He comes back well prepared for practical work in the gas profession, which he has already entered; and we are sure that all wish him much success in his chosen field.

THE "Economic" gas process vendor is still in the land, as witness the following letter received a few days ago by the Manager of a Gas Company in one of the States in the great Northwest. We are sure our readers will appreciate the "beautiful simplicity" of the vendor's agrument, so we reproduce the same without further comment: "* * * I take the liberty of writing to you to explain the merits of the Economic gas. My object in so doing is that I represent the Company in * * *, with a view of selling State or county rights for the manufacture of the same. I have just shown the light in * * * * city, and have parties figuring on the State rights, and thinking it possible that you might wish to purchase the county right for * * * * county, I write you this explanation of what Economic gas is. First, I will say that this gas was patented on the 19th of July, 1892, therefore is now in its infancy to the public, but was experimented with for years, and found by experts to be far ahead of all gas patents in the United States or Europe, before patent was applied for. As to the cost of manufacture. It costs less than kerosene at .30 cents (*sic*) per gallon, and is from 3 to 5 times as brilliant as incandescent light; and coal and water gas do not compare with it. It is the softest light known—very white; and the eye does not become tired looking at it. As it is perfectly steady, reading, writing or sewing by it are simply delightful. It cannot be blown out in the hardest blizzard. Purity is one of the most important features to be considered in an illuminant. This gas is absolutely pure—no odor, soot, smoke or carbonic oxide; therefore a person cannot be asphyxiated by it should the gas accidentally be turned on or the pipes leak. There is no drip whatever in the pipes. It will not freeze, and could be carried 100 miles in pipes. Under its light the retail dealer can sell goods at night just the same as in the daytime, as all colors are true to nature—a blue is a blue and a green is a green. With this light a lady can purchase drygoods at night as well as in daylight, and know as well what color she is buying. It is actually so pure and white that the finest photos can be taken at night under its light. This seems a broad assertion, but it is a fact, and is enough to convince the most skeptical of its purity, as all photographers well know that they must have a pure, white light to do their work. Sample photos taken under two burners, with one half and one minute exposures, furnished on application. It is perfectly safe, not having the explosive qualities of coal gas, and it far excels electric light. As to safety and brilliancy, the above may seem broad claims, but if you care to interest yourself or others in the purchase of such a gas, take an option on * * * county, and, if you are not satisfied after a full explanation, you will surely be nothing out, as the Company will bring the sample plant to your city, or pay your expense to * * * city, or upon your appointing a committee upon whom you can depend, the Company will take them to their nearest plant—Grand Forks, North Dakota—where they can see a plant in full operation; and, if necessary to convince, will turn the plant over to the committee, to run for any length of time, so they can satisfy themselves that the case has not been misrepresented to them. The gas is patented; but it

is no secret to those who contemplate purchasing. Hoping to hear from you soon, * * * * * *"

So blue is blue and green is green! Well, that is comforting. We might also remark that green is not current "on the lea" just now, for the simple reason that the temperature has been a trifle too low this winter. Again, the times have changed for the process man in that his "claims" are now accepted as proof of his own verdancy.

On the 15th inst,, the proprietors of the Salamanca (N. Y.) Gas Company will discontinue the manufacture of illuminating gas. They will, however, continue to distribute natural gas for fuel purposes.

The Berlin Iron Bridge Company, of East Berlin, Conn., has been awarded the contract for the rebuilding of the tube mill of Curtis & Co., at Cohoes, N. Y., which was recently destroyed by fire. Purified by their passing through the flames, the tube mill folks will have no wood in theirs this time, as the plans call for a structure to be composed entirely of brick and iron. The building will be 132 feet wide by 131 feet long, with a wing one side 20 wide by 74 feet long.

"Bois," writing to us from this city, under date of January 31st, says: "Dear Journal—Noticing in your issue of Monday last some remarks from Mr. Egner, who gives quite an interesting comparison of some four samples of gas, and suggestively enquires if it is not about time to cease calling it (the Harris gas) a 'fool gas,' instead of by its rightful title fuel gas. As a gas observer 'up a tree,' and looking the world gaseous o'er for a process to conquer or surrender to, I focus on this Harris item, to wit: Sample of Harris gas No. 1, an analysis from sources outside of Harris: Combustible substances in gas, 263.23 heat units. This is apparently according to the Dulong formulæ, burning to water, with the heavy hydrocarbon all classed as ethylene in caloric power. Taking same authority and same amount heavy hydrocarbons, 8.60 per cent., and classifying them 15 per cent. benzine and 85 per cent. ethylene, the heat unit value for the combustibles becomes 290.78, burning to water or to vapor, about 6 per cent. less heat unit power. Taking Thomsen's formulæ, same sample gas gives on a basis of 15 per cent. benzole vapor and 85 per cent. ethylene in the 8.60 per cent. heavy hydrocarbons, all the combustibles burning to water, 289.7 heat units; same burning to vapor, 272.373 heat units. And if carried out by the same formulæ, from the quantities given, 5.18 ethylene, 3.42 benzine vapor and burning to water, equal 336.299 heat units; ditto, to vapor, 316.898 heat units. Where Mr. Egner gets his 432.64 heat units, I am at a loss to determine, unless it is assumed that the substances given are 3.42 ethylene and 5.18 benzine, when possibly it might come out somewhere near his figures. Here I meet the query, 'Does the Harris continuous process of making products of combustion gas develop the benzine vapor element in preference to the ethylene?' Or, in other words, is the bridge (ethylene) between the CH_4 and C_2H_4 elements less in weight or size than the fellow that wants to get across? The sample of Harris gas (No. 2, from Messrs. Harris) I have not had time to analyze as to its heat unit power, but anticipate that there may be some shrinkage from the figures given, if it is put down to a vapor basis, the only point that the combustion of any gas reaches in practical effect outside of the laboratory. I think the sample of natural gas quoted for heat units must have been taken down near the Posey county, Indiana, line, and from a well that in the words of the Hoosier, is 'pretty near petered out.' Certainly there are hundreds of gas wells in the Pennsylvania gas belt that gave the standard 1,000 for comparison that are doing 20 per cent. better in heat unit power than the sample quoted; and as for the citing of the water gas, I find in my experience that it makes quite a little difference whose gas it is and how it is figured upon, in order to determine the result. I do not find in Mr. Egner's article any estimate, either of illuminating value or in weight of substances in the gas, of the foundry facing or lampblack arising from the process of manufacture of the Harris gas; however, as I have no data relative to the illuminating or heating effects of these articles, I do not know as they need be regarded. The Harris process is certainly a very interesting one, and I am waiting for the time, and that Act of Congress, that will enable them to get a pipe outside of the ring in which they are bound at Washington, so they can show the world how to make gas otherwise than on paper and to burn it in other places than in some other fellow's pocket."

Judge Lane has dissolved the injunction, resulting from the petition of Mr. F. W. Stock, of Hillsdale, Mich., preventing the town from erecting a municipal electric lighting plant, which injunction rested on the allegation that the resolution providing for the same did not emanate from a legal majority of the Council. The Judge in effect decides that the erection of such a plant is still optional with the Council.

At the annual meeting of the Evansville (Ind.) Gas and Electric Light Company the following Board of Directors was chosen: Messrs. R. K. Dunkerson, Samuel Bayard, Francis J. Reitz, T. E. Garvin, John Gilbert, Jacob Weintz, Jacob Eichel and Herman Wilkiemeyer. The Directors organized by naming the following executive management: President, R. K. Dunkerson; Vice President and General Manager, Herman Wilkiemeyer; Treasurer, Samuel Bayard; Secretary, Jas. H. Foster. The notable changes in the executive management are the election to the Board of Directors of Mr. Herman Wilkiemeyer and his elevation to the dual post of Vice-President and General Manager, promotions that are forcible witnesses to the excellence of his work in connection with the Company, to the affairs of which he was a total stranger something like two years ago. Surely the ex-President of the Ohio Association is to be congratulated by his fellows on the steadiness of purpose that has carried him onward and upward, and his well earned success ought to be a spur to the youngsters of his time to keep them in similar ways. Of course, Mr. Wilkiemeyer's new position will carry with it the virtual engineering control of the Company's plant. The Evansville *Courier*, in alluding to the action of the Company in respect to its practical estimate of Mr. Wilkiemeyer's worth and faithfulness, says: "The chief management and policy of the Company will entirely rest in the hands of Mr. Wilkiemeyer—a gentleman who has been scarcely two years in this city. Coming here an entire stranger, he soon displayed the capability and ability which so steadily advanced him to his present official position. During his brief management he has proven himself a public benefactor, inasmuch as he has reduced the price of gas from $1.50 and $1.25 to $1.25 and $1 per 1,000, at the same time elevating the standard of quality. The fact cannot be questioned that henceforth Evansville will receive the very best service that it is in this gentleman's power to give, and also that the business of the Evansville Gas and Electric Company will be conducted in a uniform, courteous manner, and upon purely business principles."

The proprietors of the Macomb (Ills.) Gas and Electric Light Company have determined to add an incandescent outfit to their present arc equipment, the same to have a capacity of 1,500 lamps, of 16 candle power each.

The latest story about the disgruntled gas consumer is: "I can't understand, it," said Mr. Gewgaw at the gas office. "Last month my bill was $16 and this month it is $30. I haven't burned a bit more gas this month than I did last. Now, how in the name of honesty do you account for that?" Said the clerk: "You did not pay last month's bill!"

The firm of Messrs. F. H. Odiorne & Co., which firm was recently deprived by death of two of its controlling spirits—Messrs. Austin M. C pp and F. H. Odiorne—will be continued under the same corporate name by Messrs. A. Parker Browne and Odiorne Swain. The offices will also be continued at No. 86 State street, Boston.

The Gloucester (Mass.) Gas Light Company is to enlarge its plant, by the erection of a new retort house, to contain four benches of sixes.

The Berlin Iron Bridge Company, of East Berlin, Conn., will also build new machine shops to the order of S. F. Hodge & Co., Detroit, Mich. The building will be 150 feet long, and the central portion to be 40 feet in width, controlled by a travelling crane of 20 tons capacity. Two wings, one on each side, and two stories high, will spring from the main building. The structure will be put up in accordance with the latest plans, and when the same is completed the Hodge Company will have one of the best machine shops in the Northwest.

Through the courtesy of Mr. E. A. Pinkney, General Manager of the Equitable Gas and Electric Company, of Utica, N.Y., who writes under date of January 31st, we are enabled to thus supplement our mention of last issue respecting the recent explosion at the works of the Equitable Company: To the Editor American Gas Light Journal: On the morning of January 19th, at 4:10 o'clock, an explosion of gas occurred in the meter room of our plant, due, in my opinion, to some sudden escape of gas filling the building, there being a jet burning, a "rupture" followed. A workman was in the room a few moments prior to the accident, and as he failed to detect any indication of a leak, I am led to the opinion expressed above. The walls of a building, 26 feet by 60 feet, were entirely demolished. One of these fell in upon the purifying boxes, causing but slight damage; another, falling outward, broke off both

drip pumps to our 200,000 cubic foot holder. Some of the bricks were projected with a velocity sufficient to injure the three bottom sheets of the outer section of the holder, which was about filled at the time of the accident. The escape of gas through the broken pumps was stopped by sealing-off the drips. The station meter, governor, and eleven 12 inch valves were somewhat injured. At this writing all have been put in good repair—except holder, a temporary building put up, and matters are practically normal. No permanent rebuilding will be attempted until warmer weather conditions permanently prevail. The total loss was about $3,500. and a satisfactory adjustment of insurance has been made. No interruption to business has been occasioned, and no one was injured, for which we feel grateful.—Very truly yours, E. A. PINKNEY.

MR. JOHN KEMPF, Jr., who manages the works of the Salt Lake City (Utah) Gas Company, has applied to the Council of Provo City, Utah, for a franchise permitting him to build and operate a gas works at Provo. His application is being considered by the committee on judiciary.

ANOTHER attempt is underway for the establishing of a gas works at Ludington, Mich., which seems to be a very likely place for such an enterprise. Ludington, which is the capital of Mason county, Mich., is on Lake Michigan and at the mouth of the Marquette river. It is 137 miles west by north of East Saginaw, and is on the line of the Flint and Pere Marquette Railroad. Population, about 6,500.

A CORRESPONDENT at Grand Rapids, Mich., forwards the following: "At the annual meeting of the Grand Rapids Gas Company former Directors and officers were re-elected as follows: President, Thomas D. Gilbert; Vice-President, Noyes L. Avery; Secretary and Treasurer, H. D. Walbridge; additional Directors, Lester J. Rindge, Ph. C. Fuller and Charles F. Rood. The Directors, in their report of the business of the past year, say that the increase in the demand for gas is unparalleled, the output having been nearly 19 per cent. larger than in 1891. The increase in the number of meters set over 1891 was 547. This clearly indicates that for all round use gas is holding its own against the competition of electricity. Hundreds of citizens have demonstrated the fact that gas at $1 per 1,000 cubic feet is the most economical fuel for many domestic uses, and more than 1,200 families are using it for their cooking, and a great number of small heaters are in use. The report says: 'There has been a gratifying increase in the number of our customers who get their gas at 80 and 90 cents per 1,000 cubic feet, by reason of the large amount they use. We have laid nearly 5 miles of street mains during the year and 4 miles of service connections, and expect to lay as much more during the current year. Our manufacturing capacity has been increased 50 per cent., and we have built and enclosed a new double lift holder of the capacity of 300,000 cubic feet. Our works have been kept in good order and we have declared our usual quarterly dividend of 2½ per cent. There is a general complaint of the expense and inefficiency, of our method, or want of method, in lighting our streets, and we do not hesitate to say that if the Common Council will give us a chance we will show them a better and much more economical way.'"

THE works of the Northwestern Gas Light Company, at Evanston, Ills., were badly damaged last month through an explosion of gas. The escape it seems originated in the purifying box connections. The damage amounted to about $6,000.

REPRESENTATIVE KESSLER has introduced a jewel of a bill in the lower branch of the Nebraska Legislature, which provides that no hotel keeper in the State shall illuminate his premises by means of water gas, under pain of incurring a fine of $10 per day during the time such illumination is kept up. The bill also stipulates that each hotel keeper shall be held responsible for any death that may occur on his premises through the inhalation of illuminating gas, which we suppose means that the hotel keepers shall be open to the charge of manslaughter if it is shown that a guest has inhaled gas sufficient to cause his taking off.

ONE of the first results of the practical consolidation of the electric lighting companies of San Francisco, Cal., is an appreciable increase in the rates for a commercial service. The Edison branch of the combination has promulgated the following schedule for an arc service on commercial account: One arc light (burning all night) during April, May and June, $4 per *week;* same, during March and July, $4.25; same, February and August, $4.50; same, January and September, $4.75; same, October, November and December, $5.

THE residents of New London, Conn., are growling deeply over the wretched service that is their lighting portion at the hands of the proprietors of the New London Gas Light Company. The worst of it all is that the growls are vented with much reason, for the gas supplied by the Company is very poor in respect of lighting value, purity and quantity.

ANOTHER bill aimed at the gas suppliers of Boston was recently introduced in the Massachusetts Legislature. It is as follows:

Section I.—That no person who has been a member of the Gas and Electric Light Commission, or in its employ, having had access to its archives, consultations, business or affairs, shall be employed by any gas company doing business in this Commonwealth, as counsel, or in any other capacity, until a period of five years shall have elapsed since said service or under said Commission.

Section II.—That committees of the Legislature shall refuse to hear any such person acting before them as counsel for gas companies.

Section III.—That every gas company doing business in this Commonwealth shall annually report to the Gas and Electric Light Commission in its annual report to that Board all persons in its employ, in any capacity, who have ever been connected with the said Commission.

Section IV.—This Act shall take effect upon its passage.

IT is said that the proprietors of the Lowell (Mass.) Gas Light Company have determined to install a water gas annex plant, as an auxiliary to their present coal gas works.

THE Phillipsburg (N. J.) Gas Light Company has decided to rebuild its storage holder this season.

AT the annual meeting of the Akron (O.) Gas Light Company the reports of the officers showed that the quantity of gas sent out in 1892 exceeded that sent out in 1891 35 per cent. During the year improvements on manufacturing plant and distribution system absorbed the sum of $22,300, and because of this expenditure no dividend was declared. This season the Company will put down 5 miles of additional mains. The Directors chosen were Messrs. Gordon W. Lloyd, Ferd. Schumacher, George T. Perkins, Ernest F. Lloyd, M. O. Hower, George Dunlap and F. M. Atterholt. The Superintendent is Mr. James W. Lane, and to his energetic supervision and to the liberal policy of the President, Mr. Gordon W. Lloyd, the Company is now pretty close to the point of being a permanent, dividend payer. Mr. Lloyd deserves much praise for his persistence and courage in bringing the gas supply of Akron to a point where it is not only no longer a reproach but a credit to the city and to the Company.

THE shops of the Milwaukee Gas Stove Company, 19 and 21 Erie street, Milwaukee, were badly damaged by fire about a fortnight ago. The loss is put at $13,000.

AT the annual meeting of the shareholders in the Helena (Mont.) Gas and Electric Light Company the following officers were chosen: Trustees, C. K. Wells, H. M. Parchen, T. H. Kleinschmidt, R. L. McColloh, C. W. Cannon, A. M. Holter and H. Gans; President, C. K. Wells; Vice-President, H. M. Parchen; Secretary and Treasurer, H. L. Walker.

JUDGE SHIRAS, of the United States Court for the Dubuque (Iowa) district, has ordered that the plant of the Dubuque Electric Light and Power Company be sold at auction on March 1st to satisfy the demands of its creditors.

MOORESTOWN, N. J., is tired of its experience with incandescent electric lights as street illuminators. Lamps of the 25 candle power variety were used there, and the authorities ask that they be empowered to substitute arc lamps. Under the estimates, the public lighting by the arc system will cost $1,000 per annum more than by the present means, but the service will be at least 100 per cent improved.

THE proprietors of the Hanover (N.H.) Gas Company offer that plant for sale, and couple the notice with the rather chilling intimation that if the plant is not disposed of by July 1, 1893, it will be shut down.

MAYOR MATTHEWS, of Boston, insists strenuously that the city is paying far too high rates for her public lighting, which includes both gas and electricity.

THE Waltham (Mass.) Gas Light Company's last semi-annual dividend was 4 per cent.

THE Pintsch system plant at the works of the Chattanooga (Tenn.) Gas Light Company will be completed by February 20th.

The Market for Gas Securities.

During the week nothing particularly notable transpired in respect to the trading in city gas shares, although Consolidated was in fairly good demand, and at prices higher than those of the closing for last week. To day (Friday) Consolidated opened at 136 bid, and there was evidently more disposition on the part of traders to buy than to sell. This figure shows a net gain of two points for the week. Rumor is busy with the great things that are to be done in the way of real estate changes by the Company, but most of these suggestions are merely results of the speculative type of mind readers, whose concentrated imaginings are not worth the attention even of a curbstone financier of the genus tout. Irving Place itself can hardly declare what the future set policy of the Company is to be, simply for the reason that the schemes for change are still in the skeleton stage. In the meantime the Legislature has two or three, or even more, propositions interfering with gas matters in the State before it, the most notable of which probably is the ill-smelling proposition of a year ago to reduce the gas rate in *cities* of under 100,000 population to $1.25 per 1,000. We do not think there is much fear of this measure becoming a law, because some of the political combination in the State that now reigns are largely interested in gas shares—the Albany and Troy varieties, for instance. However, Mr. Kelly, of the House Committee on Gas, Water and Electricity, is a very industrious young man, and as this is likely to be his last term as a legislator, no doubt he would like to leave his mark behind him. Equitable keeps up to the 200 notch and Mutual goes along evenly. Standard is steady, both as to the preferred and the common.

Over in Brooklyn the situation is unchanged, practically, although quotations are all much higher. Mr. Addicks' plans are being vigorously pushed, but we imagine that that gentleman was wholly unprepared for the move recently made by General Jourdan and others, who recently made a trip to Boston for the purpose of carrying the war into Africa. It is pretty well understood that the gentlemen succeeded in convincing Dr. Amory, of the Brookline (Mass.) Company, which supplies gas in a certain district of Boston, that the price they offered for control in the Company was worth taking. So it seems that Mr. Addicks is to be matched at his own game, and that the first move is in a direction where the Addicks armor is very thin. Take it all in all, the Boston situation threatens to take on a shape almost as complicated as the Brooklyn one, and the next step will be watched with interest. The affair also promises to give the Massachusetts State Commission plenty to do. Bay State gas is weak at 53 to 54. Chicago gas is strong, and Baltimore Consolidated is bid for at 62½. We note a sale at auction of 100 shares Equitable Gas Light Company, of Memphis, Tenn., at 60½.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 Wall St., New York City.

February 6.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	136	—
Central	500,000	50	90	95
" Scrip	220,000	—	—	100
Equitable	4,000,000	100	198	200
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	142	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co—				
Common Stock	5,000,000	100	35	40
Preferred	5,000,000	100	88	91x
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	138	—
Citizens	1,200,000	20	—	—
" S. F. Bonds	320,000	1000	—	103
Equity Gas Light Co	2,000,000	100	45	—
Bonds	1,000,000	—	70	75
Fulton Municipal	3,000,000	100	155	158
" Bonds	300,000		102	—
Peoples	1,000,000	10	115	120
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	—	165
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	165	—
" Ctfs	700,000	1000	99	100

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